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ORIGINAL ARTICLE

Effects of test stress during an objective structured clinical examination

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Objective: The existence of test stress has been widely reported among professional students. To our knowledge, no studies exist that explore student stress response to objective structured clinical examinations. The aim of this study was to evaluate possible correlations between stress and objective structured clinical examination performance in a sample of chiropractic students.

Methods: A total of 116 students completed a 2-part questionnaire to assess test stress and the physiological symptoms and signs of stress. Heart rate, systolic blood pressure, and diastolic were measured during the physical examination laboratory class within the first 3 weeks and then again just prior to their objective structured clinical examination in week 5. Statistical tests were then performed for questionnaire data, heart rate and blood pressure differences, and correlation between the objective structured clinical examination grade and symptoms and signs.

Results: Questionnaire results showed that 5.1%–22.4% of students sometimes or often felt a certain degree of stress. More than 50% had 1 or more physiological symptoms and signs of stress. The objective structured clinical examination heart rate (75.23 ± 11.20 vs 68.16 ± 8.82, $p < .001$), systolic blood pressure (120.43 ± 9.59 vs 114.97 ± 11.83, $p < .001$), and diastolic blood pressure (73.00 ± 7.93 vs 69.32 ± 7.76, $p < .001$) were significantly higher than baseline. There were also negative linear correlations between objective structured clinical examination grades and physiological symptoms and signs and between objective structured clinical examination grades and feeling statement score.

Conclusion: The results support our hypothesis that chiropractic students experience stress when performing the objective structured clinical examination and that high levels of stress had a negative impact on performance.

Key Indexing Terms: Chiropractic; Education; Examination, Physical; Stress, Psychological

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INTRODUCTION

The term *stress* was first used in a biological context by the endocrinologist Hans Selye.[1] It refers to the sum of physical, mental, and emotional strains or tensions on a person. Medical school training has always been regarded as highly stressful. In 1989, Vitaliano et al[2] found that average medical student anxiety level was at the 85th percentile compared to that of the general population. Saipanish[3] reported prevalence and sources of stress among Thai medical students. He found that 61.4% of the 686 students evaluated had elevated stress, and 2.4% experienced a high level of stress. Exams were the most common cause of stress.[3] A 2005 Swedish study assessed potential stressors and prevalence of depression among 342 medical students in different program years. They found that the prevalence of depression in the medical students was 12.9% vs 7.8% in a control group, and year 1 students experienced the highest levels of stress.[4]

To date, few studies have quantified and qualified stress levels in chiropractic training programs. Spegman and Herrin[5] reported chiropractic students' perceptions of stress and clinical confidence. Their 85 student participants reported multiple sources of stress and demonstrated an inverse relationship between stress and clinical confidence. In a study of 57 1st-trimester chiropractic students, Schutz et al[6] reported significantly higher levels of anxiety among students with higher grade point averages. Later, Schutz and coworkers[7] also found that anxiety was a strong predictor of academic performance in 69 chiropractic students. Kinsinger et al[8] reported a 25% prevalence of depression symptoms in 1303 chiropractic students. Test anxiety prevalence among college students has been estimated to be 15%–20%.[9] Consequently, test stress is likely to be a component of student life, including that of chiropractic students, that needs to be acknowledged and managed effectively to ensure student success.

In our chiropractic training program, students take 25–30 written and laboratory practical examinations each

Table 1 - Student Responses to Questionnaire

Feeling statement	Never (%)	Rarely (%)	Sometimes (%)	Often (%)
I feel:				
Excessive, ongoing worry and tension	51 (44.0)	39 (33.6)	16 (13.8)	10 (8.6)
Restlessness or a feeling of being "edgy"	41 (35.3)	49 (42.2)	18 (15.5)	8 (6.9)
The need to go to the bathroom frequently before OSCE	73 (62.9)	20 (17.2)	14 (12.1)	9 (7.8)
Trouble falling or staying asleep last night	76 (65.5)	19 (16.4)	10 (8.6)	11 (9.5)
Being easily startled	85 (73.3)	25 (21.6)	2 (1.7)	4 (3.4)
Irritability	78 (67.2)	20 (17.2)	16 (13.8)	2 (1.7)
Difficulty concentrating	57 (49.1)	37 (31.9)	19 (16.4)	3 (2.6)
Symptom and signs	**Yes (%)**		**No (%)**	
Nausea	8 (6.9)		108 (93.1)	
Headache	13 (11.2)		103 (88.8)	
Muscle tension	26 (22.4)		90 (77.6)	
Palm sweating	64 (55.2)		52 (44.8)	
Trembling	29 (25.0)		87 (75.0)	

OSCE indicates objective structured clinical examination.

quarter. Multiple studies have shown that positive instructor feedback after an examination can motivate students.[10,11] Objective structured clinical examinations (OSCEs) can be used in relatively low-stakes scenarios as practice. While effective at providing feedback to students, practice OSCEs can lead to high levels of stress due to the timed and interactive nature of these examinations.[12] Therefore, it is likely that chiropractic students experience high levels of test stress, especially during OSCEs. However, there have been relatively few studies at chiropractic colleges examining the relationship between test stress and academic performance, particularly on OSCEs.[13]

Therefore, the purpose of this study was to explore student stress levels in a chiropractic training program and to evaluate possible correlations between stress and OSCE performance. Specifically, we predicted that test stress exists among chiropractic students prior to and during OSCEs (in a laboratory physical examination setting) and that overt physical signs of stress would be readily quantifiable.

METHOD

Subjects

A total of 116 chiropractic students (67 males and 49 females) volunteered to participate in this study during the 2011 academic year. These 3rd-quarter students were enrolled in a physical examination (PE) course as part of a 13-quarter chiropractic training program. Student ages ranged from 22 to 48 years. The institutional review board of Palmer College of Chiropractic approved this study, and permission was obtained from all students to use deidentified performance assessments for the study and subsequent publications. All students were taught the laboratory PE procedures by the same instructor and took the same laboratory examinations.

Student Questionnaire

Study participants were asked to complete a questionnaire consisting of 2 parts based on their perceptions a week prior to the OSCE. See Table 1 for the questions asked on the survey. Part 1 assessed test stress, while part 2 inquired about physical symptoms (e.g., nausea, headache, and muscle tension) and signs (e.g., palm sweating and trembling). Each part-1 question was scored 1–4 (never, rarely, sometimes, or often), and possible scores ranged from 7 to 28. Each physical symptom question and sign in part 2 was scored 0 or 1 (yes = 1, no = 0). The questionnaire used in this study was derived from the criteria of the generalized anxiety disorder questionnaire developed by Roemer et al.[14] While the questionnaire has not been formally validated, the survey question face validity was obtained by consulting 2 faculty members who were content experts and 4th-quarter chiropractic students ($n = 6$) who did not participate in the study. The questions were further revised and reevaluated based on feedback from these individuals.

Procedure

We administered the survey questionnaire prior to the OSCE and conducted physiological assessments of heart rate (HR) and blood pressure (BP) twice during the course of the study (Fig. 1). The first assessment (baseline measurement) was recorded during the regular course of the PE lab in the first 3 weeks of the term, when students were considered to be at their lowest stress state because they had no examinations during that time period. The second assessment was recorded 10 minutes prior to their OSCE in week 5 (OSCE measurement).

Both BP and HR measurements followed the methods described in *Clinical Methods: The History, Physical and Laboratory Examinations*.[15] An upper-quarter chiropractic student was trained and deemed proficient by the course instructor to measure BP. Participants were seated with the cuff placed on the right upper arm and the arm resting on a table at heart level. Cuff size was adjusted after measuring the arm circumference. The stethoscope head was placed over the subject's brachial artery in the antecubital fossa. The cuff was inflated until no arterial sounds were detected and then slowly deflated as vascular turbulence was

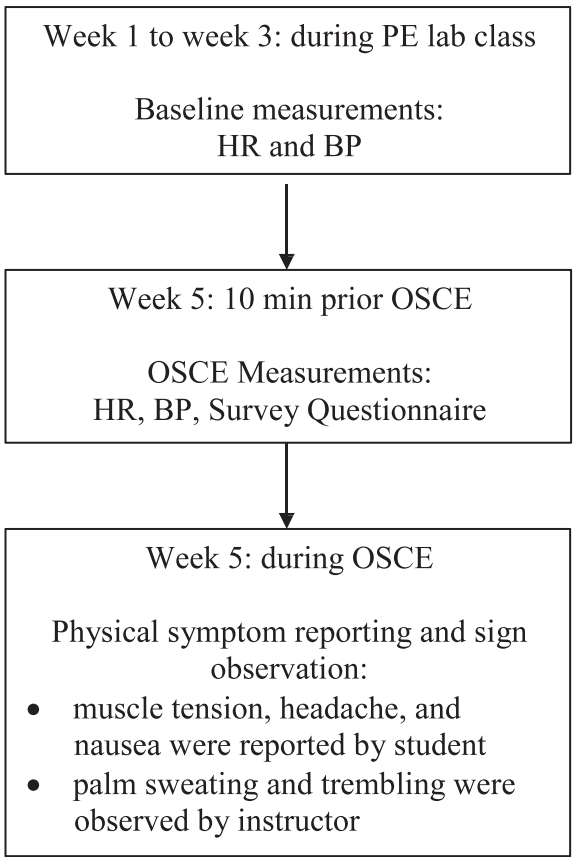

Figure 1 - Study flow chart.

monitored (Korotkoff sounds). The first pulse sound was registered as systolic blood pressure (SBP), and the pressure level at which the sound pulse disappeared (5th Korotkoff sound) was recorded as the diastolic blood pressure (DBP). The same upper-quarter student then measured the subject's HR by palpating the radial pulse. The subject's radial artery was compressed with the assessor's index and middle fingers for 15 seconds, and that rate was then multiplied by 4.

The presence and absence of palm sweating was assessed immediately after the OSCE, while trembling was noted during the procedures by the OSCE assessor. Both are recorded as a part of the questionnaire by the same assessor.

Data Analysis

For questionnaire data, we used frequencies to calculate the percent of the total in each statement item and each symptom and sign.

Three statistical analyses were performed. A paired *t* test was used to assess HR and BP differences between the baseline and OSCE assessment periods. Then, exploratory data analyses were used to determine which factor or combinations of factors, such as HR or headache, affected the OSCE results. Once these factors were determined, students were assigned pre–OSCE state groups based on matching factors. Those who had all factors that affect their OSCE results according to the exploratory data analyses were put in 1 group, and all others were assigned to a different group.

An independent *t* test was then used to determine OSCE score differences between these groups. Lastly, linear correlation analysis was performed to evaluate the correlation between OSCE grade and score of symptoms and signs, score of the student feeling statement, and the changes of HR and BPs. Data were analyzed using SPSS version 22.0 (IBM Corp, Armonk, NY), and the α level was set at .05 for all analyses.

RESULTS

Survey Questionnaire

All percentages below refer to the sum of "sometimes" and "often" from Table 1. The questionnaire revealed that all students most often felt "restlessness" or feelings of being "edgy" (22.4%), "excessive, ongoing worry and tension" (22.4%), followed by "the need to go to the bathroom frequently" (19.9%), "difficulty concentrating" (19%), "trouble falling or staying asleep last night" (18.1%), "irritable" (15.5%), and "being easily startled" (5.1%). The mean feeling score for all students was 4.69 (SD $\pm$ 4.55). A total of 36 students' (31%) feeling statement scores were 0.5 SD or more above the mean score.

The instructor observed palm sweating and trembling in 55.2% and 25% of the participants, respectively. Students also self-reported muscle tension (22.4%), headache (11.2%), and nausea (6.9%) (Table 1). The mean physical symptom and sign score for all students was 1.18 (SD $\pm$ 1.12). A totalt of 13 students' (11%) symptom and sign scores were 0.5 SD or more above the mean score.

Comparisons Between Baseline and OSCE Measurements in HR and BP

There were statistically significant increases in mean BP and HR between baseline and the OSCE (Table 2). Of 116 students, 88 students (75%) had an increase in HR, 70 students (60%) had an increase in either SBP or DBP, and 50 students (43%) had an increase in both SBP and DBP. A total of 41 students (35%) had an increase in both HR

Table 2 - Mean $\pm$ 1 SD Heart Rate and Blood Pressure Between Baseline and OSCE Measurements

	Baseline ($n = 116$)	OSCE ($n = 116$)	*p* Value
Heart rate	68.16 $\pm$ 8.82	75.23 $\pm$ 11.20	$< .001$
Systolic BP (mm Hg)	114.97 $\pm$ 11.83	120.43 $\pm$ 9.59	$< .001$
Diastolic BP (mm Hg)	69.32 $\pm$ 7.76	73.00 $\pm$ 7.93	$< .001$

BP indicates blood pressure; mm HG, millimeters of mercury; OSCE, objective structured clinical examination.

Table 3 - Correlation Coefficient Between OSCE Grade and Symptom/Sign Score, Feeling Statement Score, Change of HR, and Change of BPs ($n = 116$)

Variable	1	2	3	4	5	6
1. OSCE		−.29*	−.28*	−.09	−.10	−.14
2. Symptom/sign			.50	.16	−.03	−.05
3. Feeling statement				.13	.18	.24
4. Change of HR					.09	.06
5. Change of BPs						.59
6. Change of BPd						

OSCE indicates objective structured clinical examination; HR, heart rate; BPs, systolic blood pressure; BPd, diastolic blood pressure.
* $p < .01$, 2-tailed.

and BP. Sixty-nine students (59%), 59 students (51%), and 61 students (53%) had an increase of 0.5 SD or more above mean of baseline in HR, SBP, and DBP, respectively.

Change of Physiological Signs (HR and BP) and OSCE Grades

When we compared the OSCE grades between students with ($n = 67$) and without ($n = 49$) a change of 1 physiological indicator (HR or BP), we found no significant difference between students in these 2 groups ($\bar{x} \pm 1$ SD [with] = 19.58 ± 0.67; $\bar{x} \pm 1$ SD [without] = 19.67 ± 0.66, $p = .47$). However, when we compared the examination scores of students who had an increase in both HR and BP and at least 1 symptom or sign ($n = 27$) to the examination scores of the students who did not meet these criteria ($n = 89$), there was a significant difference ($\bar{x} \pm 1$ SD [criteria met] = 19.26 ± 0.71; $\bar{x} \pm 1$ SD [criteria not met] = 19.73 ± 0.62, $p = .001$), with students meeting the criteria having significantly lower examination scores.

Relationship of the Change of Physiological Signs (HR and BP), Symptom and Sign Score, Feeling Statement Score to OSCE Grades

The linear analysis showed a moderate negative correlation between OSCE grades and symptom/sign score and feeling statement score (Table 3). There was no correlation between OSCE grades and change in either HR or BP (Table 3).

DISCUSSION

In this study, we observed that 75% of students had an increase in HR and 60% of students had an increase in either SBP or DBP. In addition, linear regression analysis showed a negative correlation between OSCE grades and symptom and sign scores. In a study of 121 medical students taking their final licensing examination, researchers found that student DBP increased significantly during the examination as compared to prior to the examination.[16] In another study of 22 medical residents, those subjects also showed that BP and HR increased significantly within the duration of an examination.[17] In a study by Zhang et al[18] using the Zung self-rating anxiety scale questionnaire to measure anxiety, they found that 31% of the students experienced anxiety during the examination period. SBP and DBP were also significantly higher in the anxiety group when compared to their no-anxiety group, and their line analysis showed a strong positive correlation between symptom and sign scores and SBP, DBP, and HR. Hence, our findings are in agreement with previously reported literature. However, our study also revealed that a small number of students (23.3%) had an increase in more than 1 physiological indicator, as well as more severe symptoms such as nausea and headache. Numerous studies have reported physiological changes in response to mental stress. Lucini et al[19] found that psychological stimuli influence cardiovascular reactivity, and James et al[20] reported that mental activity can induce BP changes. In animal models, mental stress increased sympathetic activity, with associated increases in arterial BP and HR.[21] In 2011, Zhang et al found that preexamination BPs were significantly higher in the anxiety group than in the no-anxiety group.[18] Hence, we measured HR and BP, as well as other signs and symptoms associated with anxiety in this study. Therefore, our study suggests that physiological assessment could also be a useful tool in assessing student stress.

Traditionally, there are 2 types of stress states, eustress and distress. Energetic arousal and motivation act as eustress and tense arousal or frustration act as distress.[22] Our results showed that a majority of students expressed either 1 symptom or an increase in 1 physiological sign of stress prior to their OSCE. When we compared the examination scores of these students, we found that their performance did not deteriorate when compared with those students who had no symptoms or physiological sign changes. We speculate that the expression of a single symptom or an increase in a single physiological sign was the result of low stress state (eustress). Only 18.1% of students experienced either nausea or headache or both, and 23.3% of students experienced nausea and headache and an increase in BP and HR. We consider these to be high stress states (distress). Most importantly, the test scores of the students experiencing distress were lower than those students who had eustress or no stress at all. Hence, our results support the hypothesis that chiropractic students experience stress in response to examinations and that too much stress, or distress, can negatively affect their academic performance.

It is indicated by this study and others that students experience test stress both in the form of eustress and distress. Several explanations for why this occurs have been suggested in the literature. One possible explanation may be that students are unclear about examination criteria or performance standards, which may cause nervousness. Critical observation by their instructor has also been reported to increase stress.[23] Moreover, when students become preoccupied with the potential for negative overcomes, such as making a mistake, performance can be negatively affected due to misdirection of attention away from the task at hand.[24] Any 1 or more

of these hypotheses may explain why students with high test stress (distress) performed more poorly on their OSCEs in our study and presents an area of future research for us.

Limitations

Several of the variables measured in this study may be influenced by factors other than the OSCE. For example, personal or financial problems can be large stressors in a student's life. Vital signs may also be altered by the use of caffeinated drinks immediately prior to the examination. Improvements can be made by modifying the questionnaire to include confounding variables and later adjusting for them in the data analysis. Furthermore, the questionnaire and vital sign measurements can be administered multiple times throughout the semester to establish a more robust set of baseline data.

The results of this study are limited to students performing OSCEs in a chiropractic training program. It would be important to determine if the effects of stress state on academic performance could be replicated in other health care professions.

CONCLUSION

The relationship between stress and performance is complex. Because our students experienced both eustress and distress with their OSCEs, we can conclude that chiropractic students are not unlike students in other graduate or professional training programs in their response to examinations. Although eustress can enhance learning ability[25] and is expected prior to and during an examination period, distress may adversely affect academic achievement[26,27] and may even result in psychological and physiological disorders.[28,29] We hope that our study will lead to a better understanding of the relationship between the types of stress, particularly as it relates to examination methods, and allow faculty to better recognize distress in students. While certain steps can be taken to reduce stress, such as clear expectations, others (ie, observation) cannot be avoided.

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Author Contributions

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REFERENCES

1. Selye H. A syndrome produced by diverse nocuous agents. 1936. *J Neuropsychiatry Clin Neurosci*. 1998; 10(2):230–231.
2. Vitaliano PP, Maiuro RD, Russo J, Mitchell ES. Medical student distress: a longitudinal study. *J Nerv Ment Dis*. 1989;177(2):70–76.
3. Saipanish R. Stress among medical students in a Thai medical school. *Med Teach*. 2003;25(5):502–506.
4. Dahlin M, Joneborg N, Runeson B. Stress and depression among medical students: a cross-sectional study. *Med Educ*. 2005;39(6):594–604.
5. Spegman AM, Herrin S. Chiropractic interns' perceptions of stress and confidence. *J Chiropr Educ*. 2007;21: 129–137.
6. Schutz CM, Gallagher ML, Tepe RE. Differences in learning and study strategies inventory scores between chiropractic students with lower and higher grade point averages. *J Chiropr Educ*. 2011;25:5–10.
7. Schutz CM, Dalton L, Tepe RE. Learning and Study Strategies Inventory subtests and factors as predictors of National Board of Chiropractic Examiners Part 1 examination performance. *J Chiropr Educ*. 2013;27:5–10.
8. Kinsinger S, Puhl AA, Reinhart CJ. Depressive symptoms in chiropractic students: a 3-year study. *J Chiropr Educ*. 2011;25:142–150.
9. Hill KT, Wigfield A. Test anxiety: a major educational problem and what can be done about it. *Elem School J*. 1984;85:105–126.
10. Donnelly RC. Embedding interaction within a blend of learner centric pedagogy and technology. *WJET*. 2009; I(1):6–29.
11. Hawkins SM, Heflin LJ. Increasing secondary teachers' behavior-specific praise using a video self-modeling and visual performance feedback intervention. *J Positive Behav Interv*. 2011;13(2):97–108.
12. Zartman RR, McWhorter AG, Seale NS, Boone WJ. Using OSCE-based evaluation: curricular impact over time. *J Dent Educ*. 2002; 66(12):1323–1330.
13. Zhang N, Henderson CNR. Test anxiety and academic performance in chiropractic students. *J Chiropr Educ*. 2014;28(1):2–8.
14. Roemer L, Borkovec M, Posa S, Borkovec TD. A self-report diagnostic measure of generalized anxiety disorder. *J Behav Ther Exp Psy*. 1995;26:345–350.

15. Walker HK, Hall WD, Hurst JW. *Clinical Methods: The History, Physical and Laboratory Examinations*. 3rd ed. Boston, MA: Butterworth-Heinemann; 1990.
16. Zeller A, Handschin D, Gyr N, Martina B, Battegay E. Blood pressure and heart rate of students undergoing a medical licensing examination. *Blood Press*. 2004;13(1): 20–24.
17. Marazziti D, Ambrogi F, Abelli M, et al. Lymphocyte subsets, cardiovascular measures and anxiety state before and after a professional examination. *Stress*. 2007;10(1):93–99.
18. Zhang Z, Su H, Peng Q, Yang Q, Cheng X. Exam anxiety induces significant blood pressure and heart rate increase in college students. *Clin Exp Hypertens*. 2011;33(5):281–286.
19. Lucini D, Norbiato G, Clerici M, Pagani M. Hemodynamic and autonomic adjustments to real life stress conditions in human. *Hypertension*. 2002;39:184–188.
20. James GD, Yee LS, Harshfield GA, Blank SG, Pickering TG. The influence of happiness, anger, and anxiety on the blood pressure of borderline hypertensive. *Psychosom Med*. 1986;48(7):502–508.
21. Malliani A, Pagani M, Lombardi F, Furlan R, Guzzetti S, Cerutti S. Spectral analysis to assess increased sympathetic tone in arterial hypertension. *Hypertension*. 1991;17(suppl 4):III36–42.
22. Husain A, Khan I. *Recent Trends in Human Stress Management*. New Delhi, India: Global Vision Publishing House; 2006.
23. Cheraghian B, Fereidooni Moghadam M, Baraz-Pardjani SH, Bavarsad N. Test Anxiety and Its Relationship With Academic Performance Among Nursing Students. *J Knowl Health*. 2008;3(3–4):25–29.
24. Morris LW, Engle WB, Assessing various coping strategies and their effects on the performance and anxiety. *J Clin Psychol* 1981;37:165–171.
25. Kaplan HI, Sadock BJ. *Learning Theory: Synopsis of Psychiatry: Behavioral Sciences/Clinical Psychiatry*. Philadelphia, PA: Lippincott Williams and Wilkins; 2002.
26. Elliot AJ, Shell MM, Henry KB, Maeir MA. Achievement goals, performance contingencies, and performance attainment: an experimental test. *J Educ Psychol*. 2005;97(4):630–640.
27. Trautwein U, Lüdtke, O, Marsh HW, Köller O, Baumert J. Tracking, grading, and student motivation: using group composition and status to predict self-concept and interest in ninth-grade mathematics. *J Educ Psychol*. 2002;98(4):788–806.
28. Putwain D. Do high stakes examinations moderate the test anxiety—examination performance relationship? *Educ Psychol*. 2008;28(2):109–118.
29. Putwain DW, Connors L, Symes W. (2010) Do cognitive distortions mediate the test anxiety and examination performance relationship? *Educ Psychol*. 2010;30(1):11–26.